Yujin Wang
Haolei Dai, Zibo Liu*, Dameng Liu*
Tsinghua University Haidian District, Beijing, P. R. China
wang-yj20@mails.tsnghua.edu.cn

Van Hove singularity modulation of phonon transport in Twisted Bilayer Graphene

Abstract
Twisted bilayer graphene (tBLG) exhibits remarkable optical and electrical properties, rendering it a promising material for future micro/nano devices. Nonetheless, efficient heat transport poses a critical challenge, and comprehending the influence of twist angle on phonon properties is vital. In this study, we present the first analysis of the effects of twist angle on phonon scattering near the Van Hove singularity. Our investigation reveals an extended lifetime of G mode phonon due to electron-hole pair excitation near the critical angle accompanied by a substantial enhancement response. This phenomenon occurs when electron-phonon scattering is suppressed, leading to the dominance of phonon-phonon scattering in the transport process. Our study unveils the predominant control of the phonon-phonon scattering process by three-phonon scattering, with the proportion directly influenced by the twist angle. This effect arises from the alteration in the phonon band structure, aligning with theoretical predictions acquired via molecular dynamics simulations. These findings contribute significant scientific insights into the phonon scattering behavior of tBLG, thereby informing the development of advanced micro/nano devices with enhanced performance. Furthermore, our study may open avenues for investigating the potential practical applications of tBLG and other twisted materials.

References

[1] Cao, Y.; Fatemi, V.; Demir, A.; Fang, S.; Tomarken, S. L.; Luo, J. Y.; Sanchez-Yamagishi, J. D.; Watanabe, K.; Taniguchi, T.; Kaxiras, E., et al. Nature, 2018, 556, 80–84
[2] Andrei, E. Y.; MacDonald, A. H. Nature materials, 2020, 19, 1265–1275.
[3] Trambly de Laissardi`ere, G.; Mayou, D.; Magaud, L.Nano letters 2010, 10, 804–808.
[4] Yin, J.; Wang, H.; Peng, H.; Tan, Z.; Liao, L.; Lin, L.; Sun, X.; Koh, A. L.;Chen, Y.; Peng, H., et al. Nature communications 2016, 7, 10699.

Figures

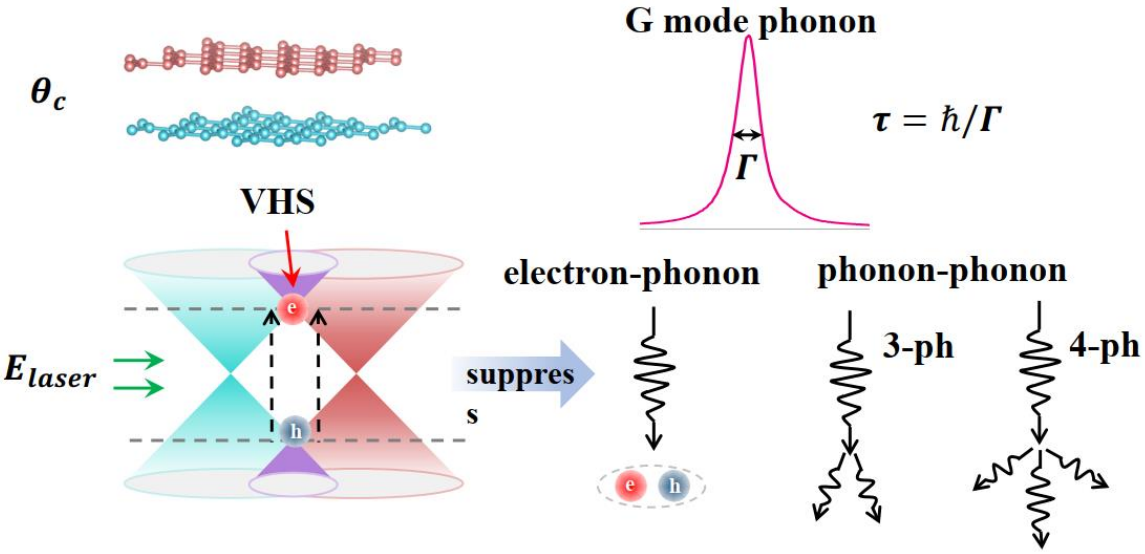

Figure 1: Table of contents